

## APPARATUS AND METHOD FOR POSITIONALLY STABILIZING AN IMAGE

This application is a continuation of application Ser. No. 08/195,422, filed Feb. 15, 1994, now abandoned.

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

This invention relates to the field of spatially stabilizing electromagnetic radiation images which are the result of radiation incident on a reflective or transmissive surface. The invention finds particular use for stabilizing projected optical images from projectors such as film and television projectors, graphics printers or images photographed by a camera such as a still video or television camera.

In the presentation, viewing or capture of images, problems often occur due to mechanical imperfections such as vibrations, distortions, tolerance buildup, wear, chemical stability, electrical noise and a host of other forms of mechanical, optical, chemical and electrical problems. These problems can cause movement, jitter and/or distortion of the image, whether the image is being presented for viewing by biological eyes, analysis by machines, viewed for entertainment or captured for storage. Electro mechanical and optical mechanical devices such as projectors and cameras are highly susceptible to such problems. These problem are present no matter what type of electromagnetic radiation is being utilized, be it optical, microwave, X-ray, cosmic rays etc. Any electromagnetic image or image instrument which is subject to mechanical vibration in the utilization thereof may be improved by the present invention.

One of the most common of mechanical effects occurs with film projectors and is called gate weave in the motion picture industry. Gate weave results in a moving and jittery image being presented on the motion picture screen when the movie is projected due to slight movement of the projected film image. The main cause of gate weave in this instance is the improper positioning of the film image in the film gate or aperture of the projector from one frame to the next. The improper positioning of the image is a result of the above mentioned problems, either in the projector, the camera shooting the film or the intermediate film processing, but most commonly is due to the wear and tear of the sprocket holes in the projected film occurring over prolonged use. The sprocket holes are used by the projector intermittent gear to position the film in the projector aperture for the momentary presentation of each frame, with the edges of the holes requiring critical alignment with respect to the film image. As the film is projected over and over, these edges tend to wear unevenly.

In addition, for very old films, chemical changes in the film emulsion and/or base cause physical distortion of the film image with respect to the sprocket holes and film edges. These problems also result in gate weave.

While it is possible to minimize the various effects mentioned above, the problem of wear of the sprocket holes as well as chemical distortion of the film emulsion or base over time remain as serious problems which are not generally correctable after the damage occurs. It is desirable then to reduce the visibility of such movement, jitter and/or distortion during the projection of the film in order to present a more stable image for the aforementioned viewing. In addition when the image is being viewed by a machine, such as by a television camera, it is often necessary to stabilize the image on the image sensing element.

In addition to film gate weave, there are many types of image presentations where image movement and jitter are

problematic, either due to the image system itself, or due to the system being required to display or view images which have had movement or jitter "recorded in". Generally, anytime it is desired to mechanically focus or align an image jitter and movement can be a problem. Such recording in often happens when the image was generated or transferred from one storage medium to another, and results in the jitter being recorded into the image. Beyond such recording in, no amount of mechanical stability correction of the image media can correct the jitter. What is needed is corrective canceling mechanical jitter of the image media itself, the image recovered therefrom or the projected or viewed image to effect stability. This corrective canceling action would be required even if the subsequent projection or viewing of the image were made without any jitter or other mechanical problems at all. For example, if a video tape recording were made of a jittering film, the present invention could preferably be used to correct the film jitter during the recording, or if such were inconvenient or impossible, the invention could be used to correct the subsequent use of the video tape recording.

Examples of such systems which might be required to display a moving, jittery or distorted image include electro and optical mechanical printers, projectors and viewers as well as television and computer displays and printers, including more familiar electronic displays.

#### 2. Description of the Prior Art

In the Prior art it is known to apply considerable mechanical precision to the movement and holding of the image bearing or image receiving element of imaging systems. In particular film projectors having elaborately designed film movement and intermittent mechanics are well known. In the field of acquiring images, such as in film and television cameras, elaborate spring, and other types of vibration and movement damping mechanisms are used, these including electromechanical gyroscope mechanisms to hold the camera or its mounting platform steady.

It is also known in the television industry to electronically correct a jittering television image by the electronic process of moving the video image signal with respect to its horizontal and vertical synchronizing pulses with the aid of complex motion detection circuits and frame memory control. Such systems do not lend themselves to improvement of existing projection and camera equipment and in particular to the improvement of existing motion picture film and television projectors.

### OBJECTS OF THE INVENTION

It is an object of the invention to stabilize an image in a first form by sensing its position with respect to a reference and altering its conveyance path in response thereto in order to improve the stability of the image in the first or another form.

It is another object of the invention to position an electromagnetic radiation image by sensing the image in a first form and altering the path of the electromagnetic radiation which creates the image in the first or a second form in order to improve the positional accuracy of the image.

It is a yet another object of the invention to stabilize an optical image by sensing its position and refracting the light which creates the image in response thereto in order to improve the stability of the image.

It is still another object of the invention to sense an optical image to be stabilized, compare the position of the image from one moment in time to another to determine a displacement value responsive to the displacement thereof in at